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November 2017 Submission of Pacific Gas
and Electric Company's Risk Assessment
and Mitigation Phase.

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**COMMENTS OF THE OFFICE OF RATEPAYER ADVOCATES
ON NOVEMBER 2017 SUBMISSION OF PACIFIC GAS & ELECTRIC
COMPANY'S RISK ASSESSMENT AND MITIGATION PHASE**

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I. INTRODUCTION

Pursuant to Rule 14.3 of the Rules of Practice and Procedure of the California Public Utilities Commission (Commission), the Office of Ratepayer Advocates (ORA) submits these comments on the November 2017 submission of Pacific Gas and Electric Company's (PG&E) Risk Assessment and Mitigation Phase (RAMP) filing, Investigation (I.)17-11-003.

II. SUMMARY

PG&E filed its RAMP after it filed its Gas Transmission and Storage (GT&S) application,¹ and ahead of PG&E's 2020 General Rate Case (GRC) filing. While ORA offers many suggestions and critiques, ORA acknowledges that the RAMP (and similarly, the Safety Model Assessment Proceeding or "S-MAP") process is one of ongoing development and learning for all parties. It will likely take multiple iterations to reach a common and agreed-upon level of understanding and usefulness in a form that the Commission and parties desire. While some of ORA's comments may overlap with issues discussed in the S-MAP proceeding, ORA's comments are intended as suggestions for improvement based solely on PG&E's RAMP report. ORA recognizes and appreciates the effort PG&E undertook to present its first RAMP submission and the filing is a good starting point upon which the Commission and other Investor-Owned Utilities (IOUs) can expand in future RAMPs.

ORA's comments are organized as follows:

Section III provides ORA's general comments on themes, concerns, or topics not specific to any of the 21 specific risks provided by PG&E;

- 1) Section IV contains ORA's comments on specific aspects of individual risks; and
- 2) Section V discusses ORA's recommendations for future RAMP filings.

In keeping with the understanding that the RAMP is an evolving process, and that this RAMP is the first of its kind for PG&E, ORA's evaluation is not intended to be a

¹ The PG&E RAMP report was filed on November 30, 2017, whereas the PG&E GT&S application was filed on November 11, 2017.

comprehensive review of all aspects of all risks. Therefore, comments or lack thereof should not be interpreted to be a definitive and/or comprehensive position on a specific risk, risk category, or risk-analysis approach.

III. GENERAL COMMENTS

A. Multi-Attribute Risk Score (MARS) Calculation Methodology

1. Trust as a Risk Consequence Category

The MARS is a metric meant to reflect PG&E's multiple objectives in assessing the range of consequences associated with a risk². Similar to the previous efforts of the Sempra Utilities, PG&E evaluated risk consequences along several different categories, including safety, reliability, and financial. However, PG&E also includes a "Trust" attribute. That category is required by PG&E "to ensure that every action to maximize safety and reduce risk is made with the customer in mind." PG&E found the trust attribute to be the least quantifiable and is measured in the current RAMP filing using customer surveys, with the consequences being drawn from one of three distributions.³

It is uncertain what tangible impact the trust attribute would have on PG&E, its employees, or its ratepayers. This is in contrast to the other consequence attributes used by PG&E, which have a direct impact to ratepayers, shareholders, employees and contractors, or environment. Therefore, ORA recommends excluding the Trust attribute in future RAMP filings.⁴

2. MARS Reweighting

PG&E should revise the weights given to each consequence category in the MARS calculation so that the consequence calculations are logically consistent. Currently, the consequence categories of the Environmental and Compliance categories both use dollars per year (\$/yr) as their natural unit, have a range of consequence of \$0-5 billion, and have a Risk Evaluation Tool (RET) weight of 5% (1% weight per \$1 billion consequence). The Financial category consequence also has a range of consequence of \$0-5 billion, but is

² PG&E RAMP Report at p. B-8

³ PG&E RAMP Report at p. B-11.

⁴ Indeed, Trust could be considered an outcome of satisfying the other objectives.

given a RET weight of 30% (6% weight per \$1 billion consequence). The fact that PG&E has multiple consequences with the same natural units (\$/yr) but different weights is illogical, as it equates to valuing a dollar spent on Financial consequences to be six times that of a dollar spent for Environmental consequences or for Compliance consequences, even though by their nature as a common measurement, the units are meant to be equivalent. While ORA does not oppose weighting of different categories generally, this issue should be remedied so that calculations are consistent. To the extent that parties (including PG&E) value avoidance of Environmental or Compliance consequences more or less than Financial consequences, nothing precludes this preference from being discussed in filings, comments, testimony, etc.

3. Risks Covered by PG&E's RAMP

PG&E chose the 22 risk events covered in this current RAMP filing by finding the risks expected to exceed a certain threshold as vetted by their Risk Evaluation Tool (RET). However, it appears based on the wide range of MARS in the 22 risk events that some risk events may not be as significant as initially anticipated. PG&E should consider replacing risks that consistently demonstrate low MARS with risk events currently just below the RET vetting threshold, or should follow the principles of the settlement in the S-MAP proceeding.

4. Methods to Account for Uncertainty

For infrequently occurring incidents, there is currently not enough data to project risk impacts without high uncertainty. However, PG&E should incorporate methods to help account for such uncertainty, such as sensitivity analysis. While several chapters already suggest methods to manage uncertainty,⁵ such methods should be incorporated for all chapters where there is little PG&E-specific data.

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⁵ Chapter 1: Transmission Pipeline Rupture with Ignition, for example, explicitly states performing sensitivity analysis is a next step.

5. Granularity of Incident Driver Data

Risk incidents frequently have multiple factors that contribute to the incident occurrence,⁶ and cannot be solely attributed to a single driver. PG&E should ensure that the incident data used in its RAMP models has the granularity to assign percentage attribution of an incident to multiple drivers.

6. Granularity of Exposure Units

As demonstrated by certain risks (for example, Chapter 10 - Transmission Overhead Conductor), risk exposure may not be evenly distributed throughout a system, and certain portions of the exposure may represent a disproportionate amount of the risk. Identifying the portions of exposure that represent higher risk can be important in identifying the proper target for mitigations. The CPUC Safety and Enforcement Division's (SED) Risk and Safety Aspects of Risk Assessment and Mitigation Phase Report of Pacific Gas & Electric Company Investigation 17-11-003 (SED Report) noted that PG&E's exposure unit for Chapter 1: Transmission Pipeline Rupture with Ignition is simply miles of transmission pipelines without differentiating characteristics of such pipe, despite the fact that "pipeline diameter and operator pressure play a significant role in determining the potential consequence."⁷ Since PG&E is already indirectly required by federal regulations to mitigate risk on gas pipelines based on population density,⁸ PG&E could, by incorporating population density exposure granularity into its risk consequence and mitigation effectiveness calculations, preferentially mitigate risk at high population density areas.

⁶ For example, Transmission Pipeline Rupture with Ignition can be caused by equipment failure, external corrosion, or incorrect operations, to name a few. In the National Transportation Safety Board's (NTSB) Pipeline Accident Report 11-01 of PG&E's San Bruno Line 132 rupture, the NTSB attributed the rupture to a welding defect, but the event was catalyzed by lack of proper communication of risks (incorrect operations) while performing equipment replacement work. See page B-20 for an example risk bowtie.

⁷ SED Report at p. 16.

⁸ Through more stringent safety requirements based on "class locations", as defined by Title 49 Code of Federal Regulations §192.5. Examples where PG&E must consider class location, and thus indirectly population density, for pipeline safety include §192.503(c): General Requirements [for Pipeline Testing], §192.611: Change in class location: Confirmation or revision of maximum allowable operating pressure, and §192.705: Transmission lines: Patrolling.

Such quantification of consequence based on population density would be prudent for all physical asset-based risks, and not just gas pipeline risks.²

While ORA understands PG&E may not currently have enough data to further categorize risks into more the more granular exposure units recommended in this section, PG&E should ensure data collection of these risks allow for such greater exposure granularity in the future.

7. Model Validation and Calibration

As more PG&E-specific data regarding the 22 risks is gathered, PG&E should employ validation techniques to ensure the RAMP model is producing reasonably-accurate results. Based on the validation, the model should be recalibrated accordingly. While multiple risk chapters in the report (e.g. Chapters 1, 4, 6, and 11) have already stated the need for model calibration, future RAMP reports should make it explicitly clear that such calibration is necessary for all chapters. Furthermore, validation will ensure the model is producing reasonable risk estimations in the first place, and whether changes to the model's structure are necessary for more accurate results.

8. Give PG&E-Specific Data Greater Weight

PG&E-specific data should be more pertinent to predicting PG&E's future risk than more general data. PG&E, therefore, should give data specific to its own facilities greater weight than data from more general sources, assuming that PG&E has properly vetted the quality of its data and has sufficient quantity of data.

B. Mitigation and Risk Spend Efficiency (RSE) Calculations

1. Calculation of RSE Scores

In its RAMP filing, PG&E provided risk reduction scores, which represent the total reduction in the MARS due to a mitigation, and RSEs, which represent the MARS reduction per dollar spent on a mitigation, based on bundled mitigations. The risk reductions for each bundle is determined by simply adding the risk reductions and costs associated with each individual mitigation. However, this approach does not account for any potential synergies or overlaps that may exist among individual mitigations in reducing

² The current method for quantifying the consequence of Wildfire Risk based on the Fire Threat Map is also an example of an appropriate method for accounting for areas of disproportionate risk.

risk. For example, two mitigations that have similar functions and overlapping exposures will have a lower actual combined risk reduction than the sum of their individual risk reduction scores. This would address the issue of artificially inflated RSEs for some mitigation plans. Similarly, considering synergy would help address the issue with foundational work having RSEs of zero despite being necessary for other important mitigations. In this case, the actual combined risk reduction would be higher than the sum of the individual risk reduction scores. ORA recommends that future RAMP filings include some attempt to evaluate mitigations by considering the potential ways in which those mitigations might affect the efficacy of other mitigations.¹⁰

For mitigations that involve the deployment of long-term capital assets, ORA recommends PG&E provide an analysis that looks beyond 2022. PG&E acknowledges in its RAMP report that its evaluation of risk reduction is limited to 2022 or earlier and that some projects with an otherwise low RSE may be proposed because the company expects additional benefits after 2022. However, for assets that have an expected lifetime of 10 or more years, there is a benefit in determining risk reduction provided by those assets in the long-term. This will allow outside parties to better consider the benefits of capital-intensive mitigations rather than relying solely on the PG&E's assessment that those particular mitigations are best for ratepayers. Additionally, looking at long-term benefits from capital-intensive projects will allow all mitigations to be evaluated on an equal footing with each other. One method worth considering is if applying a scaling factor to RSEs based on their anticipated lifetime may allow for better examination of long-term projects.¹¹

The issues of interaction between mitigations and assessing the risk reduction of mitigations on the appropriate time scale are part of a larger issue of RSE scores failing to line up with PG&E's intuitive understanding of which mitigations would provide the greatest benefit to cost ratio. There are numerous cases in which PG&E's assessment of an alternative seems to conflict with the calculated RSE. While some of these cases are

¹⁰ See comments for Wildfire (Section K) for an example where such a consideration may be useful.

¹¹ For example, a capital-intensive mitigation effort that is expected to last 10 times the length of the current risk impact timeframe could have its RSE scaled by a factor of 10.

addressed by the suggestions noted earlier, PG&E should take further steps to assess the RSE calculation or the assumptions regarding mitigation efficacies to ensure that the RSE properly captures the benefit to cost ratio of each mitigation.

2. Capturing “Below the Line” Costs

PG&E should consider back-of-the-envelope calculation methods to capture below the line¹² costs that are currently not considered in cost estimates. While each individual below the line cost may be minuscule, the combined amount of all below the line costs may be significant, as is often evidenced in life cycle analyses and life cycle assessments. For example, creating a basic economic input-output model would allow for timely and resource-light estimations to determine the order of magnitude of below the line costs.

C. Mitigation Decision Making

1. Risk Tolerance

As noted in Section II above, ORA acknowledges the preliminary nature of this RAMP filing. However, ORA notes that the risk chapters presented by PG&E do not include a risk tolerance.¹³ Only the “Nuclear Operations and Safety Core Damaging Event” has a clear threshold¹⁴ to guide their assessment of whether additional risk mitigation was necessary, and that threshold is a federal requirement.

There were many instances in which PG&E chose the proposed mitigation plan over an alternative plan with a higher RSE because the alternative plan did not provide a sufficient amount of risk reduction, suggesting that PG&E has an implicit risk tolerance. However, without making this risk tolerance level explicit for its risks, it is difficult to evaluate its claims as to whether a mitigation plan will achieve a satisfactory amount of risk reduction. While ORA understands that the concept of identifying a risk tolerance may be sensitive and controversial, it is a necessary component of any attempt to optimize risk mitigation plans. Therefore, ORA recommends that PG&E consider adopting risk

¹² i.e. costs below a certain significance threshold.

¹³ ORA understands risk tolerance to mean the maximum risk score or risk frequency that PG&E is willing to accept for any particular risk.

¹⁴ PG&E RAMP Report at p. 12-1.

tolerances, as well as an explanation of how the risk tolerance was determined, for each risk category.

2. Alternative Proposals

Many of the alternatives proposed by PG&E are simply alternative paces of work.¹⁵ While determining the pacing of mitigating work is an important component of project management, solely proposing pacing changes is not an adequate consideration in meeting the Commission's requirement for at least two alternative mitigations. ORA recommends that in future filings the utility submit alternative mitigations that are substantially different than the mitigations that are proposed or include an explanation of why it is unreasonable or impractical to do so. This is not to say that alternative mitigations should not include analysis of alternative paces of mitigations work, but rather that the alternative proposals should not consist solely of mitigations that are identical to the proposed mitigations save for the pace of work associated with the mitigation.

Similarly, the alternative proposals based on differing paces of work often have unsatisfactory explanations regarding their dismissal. Often, the justification states that an alternative mitigation with a faster pace of work was not acceptable due to a lack of resources/personnel, or that the additional work that would be done was not as critical in enhancing safety. Likewise, alternative mitigations that decreased the pace of work compared to the proposed pace were disregarded due to not providing enough safety enhancement quickly enough. However, in many cases the slower pace of mitigation work had a greater RSE compared to the proposed mitigation. Therefore, ORA recommends that in these cases that the utility state what the risk tolerance is for each risk to allow other parties to evaluate the necessity of the proposed and alternative mitigations.

Also, ORA recommends that alternative mitigations proposed by the utilities should not include mitigations that are infeasible for the utility to perform. There are some alternatives that are considered by PG&E, but are disregarded due to a lack of resources or involve tools or technology that do not yet exist. If the utility is unable to execute a

¹⁵ This includes, for example, PG&E chapters "Transmission Pipeline Rupture with Ignition", "Measurement and Control Failure - Release of Gas with Ignition Downstream", "Measurement and Control Failure - Release of Gas with Ignition at Measurement and Control Facility", and many more.

particular mitigation, then that mitigation should not count towards the two alternatives required for each risk category. Consideration of alternative mitigations is only of value if there is a fundamental assumption that all the mitigations being evaluated are feasible. Consideration of promising emerging technologies in the Next Steps section of each chapter, however, is appropriate.

Overall, ORA is concerned about the quality of the alternatives proposed. As will be discussed in further detail in the next section, many alternatives seem to be blatantly sub-optimal options,¹⁶ making the analysis of alternatives a token gesture rather than a true exercise in weighing different alternatives with different merits to choose the best option. Thus, in the future, ORA recommends that PG&E attempt to the best of its ability to present alternatives that satisfy resource and regulatory constraints and are each optimal in at least one of the selection criterion (e.g., RSE, total risk reduction, cost).¹⁷ For example, PG&E could present, when applicable, a compliance-only option that represents the minimum mitigation cost. This would help ensure that alternatives presented are truly those worth considering.

3. Optimize Spending Across Risks

PG&E's proposed mitigations encompass a very wide range of RSEs, from a low of 0.0001 to a high of 379.25.¹⁸ Rather than looking solely at each risk individually and attempting to optimize each of their RSEs separately, PG&E also should take a more holistic approach to risk mitigation. PG&E should attempt to optimize the RSE for the entire RAMP program.

4. Holistically Considering Expected Value (EV) MARS and Uncertainty

The Tail Average is the average of the worst 10% of simulated outcomes, and therefore, represent low frequency but high consequence events. PG&E's current method

¹⁶ See, for example, comments on the Wildfire Chapter (Section K) below.

¹⁷ This may not always be possible for all risks, but suggests that PG&E attempt this for as many risks possible, and present as many legitimate alternatives that may exist, even if there may only be one. The presentation of a few, quality alternative proposals rather than many mediocre ones is preferable.

¹⁸ RSEs of the mitigations proposed for the "Measurement And Control Failure – Release of Gas With Ignition At Measurement and Control Facility" and "Contractor Safety" risks, respectively.

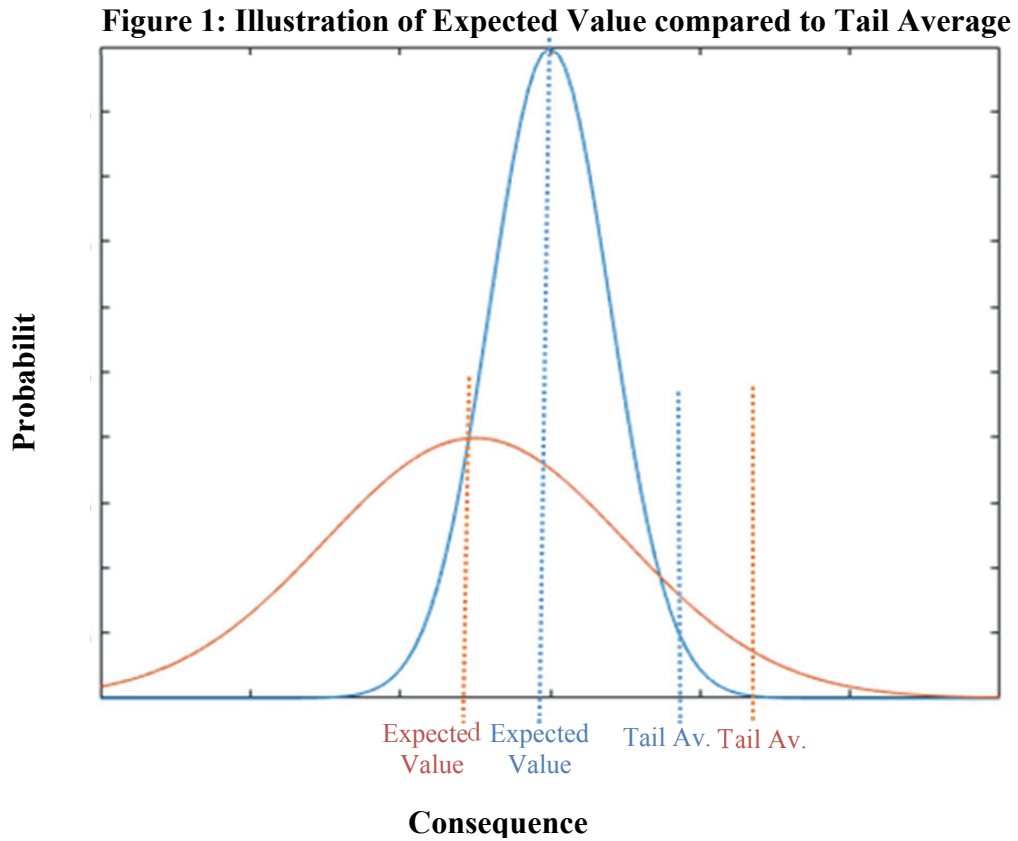
of using the Tail Average MARS and RSE as its basis for making decisions may have the unintended consequence of over-mitigating risks with high uncertainty. Risks with high uncertainty will have large ranges of possible impacts, and thus relatively high Tail Averages. PG&E then prioritizes risk spending based on these Tail Averages.¹⁹ While this risk spending prioritization will generally target risks that legitimately have large ranges in potential frequency and consequence, such a prioritization may at times make PG&E unintentionally focus ratepayer dollars on risks whose consequences are uncertain, and thus potentially insignificant, rather than mitigating risks that are more certain but have somewhat lower Tail Average consequences. Figure 1 is an illustrative example of this effect, depicting two distributions to represent the consequences of two different risk events. The orange distribution in this case represents a risk for which PG&E has less certainty regarding the consequences, and therefore has greater spread of potential consequences than the blue distribution. The orange distribution has a lower Expected Value (EV) than the blue distribution, representing lesser consequences when it comes to events that happen on a regular basis, but has a higher Tail Average consequence than the blue distribution, which means that it could potentially have greater consequences than the risk represented by the blue distribution when it comes to rare, high consequence events. If the orange distribution has this higher Tail Average because of its consequences being more uncertain rather than it legitimately having a greater range of consequences, its prioritization over the blue distribution would be diverting resources from a more appropriate risk.

To remedy this issue, PG&E should holistically consider not only the Tail Average MARS for its risks, but also the expected value for MARS.²⁰ When these two values differ substantially enough to significantly change the rankings of risks, PG&E should further scrutinize the level of uncertainty associated with such risks. If it is deemed there is an elevated level of uncertainty of the risk's Tail Average MARS, then further consideration

¹⁹ PG&E RAMP Report p. A-9: "The top risks are then flagged for senior management attention and oversight and are prioritized for assessing additional risk reduction options".

²⁰ See Proposed S-MAP settlement Agreement Element Number 24 at p. A-12 ("Use of Expected Value for CoRE; Supplemental Calculations"). As outlined in the settlement agreement, IOUs will be required to present expected values but may present supplemental calculations as well.

of the risk and efficiency in reducing the risk can more readily occur. Presenting this information would also help inform parties' and the Commission's understanding of the risks and the uncertainty around them.



D. Clarity and Transparency

1. Clarity of Results

The RAMP chapters often lack useful information, making the results of the model less clear. For example:

- The chapters within PG&E's RAMP report are inconsistent on whether they provide the anticipated percentage reduction in MARS for each risk.
- For specific mitigation measures, the chapters do not explain how the mitigation costs and projected mitigation amounts are derived.
- Finally, for mitigation measures that target multiple drivers and/or consequences, it would be helpful to provide an order of magnitude estimate of what portion of the risk reduction from this measure is attributed to each driver and/or consequence.

While many of these values are present in PG&E's work papers or could be easily calculated, future reports would have greater clarity if such results are presented explicitly.

2. Annual Risk Reduction

Besides providing values of total risk reduction in its RAMP report, PG&E also should provide annual risk reduction values. This will create greater clarity of the timeline of when risks are actually reduced, as well as give insight as to whether there are decreasing returns on the marginal benefits of risk reduction.

3. Clarity of Cross-cutting Risks

The cross-cutting risk model is used for risks that can be considered sub-drivers to many other risks and allows PG&E to focus on mitigations that are programmatic in nature.²¹ Generally, ORA agrees that there may be merit to the use of cross-cutting risk models. However, there are several issues with how these risks are presented that make them difficult to understand and evaluate. For example, there is little to no explanation of how the standalone risks that were included as "drivers" for the cross-cutting risks were selected, and the connection between standalone risk and the cross-cutting risk can seem tenuous. In addition, the way the driver frequencies are presented is inconsistent with how

²¹ PG&E RAMP Report at p. B-12

it is presented in the stand-alone risks, making it non-intuitive. In the standalone risks, the driver percentages represent the frequency that the driver contributes to the overall risk frequency. The way the cross cutting model is presented would be more analogous to that of the stand-alone risks if the driver frequencies presented in the risk bowtie represented the proportion of the Expected Value (EV) MARS from each risk rather than the portion of the stand-alone risk attributable to the cross-cutting risk.

4. List of Considered Mitigations

PG&E has likely considered mitigation efforts that it did not pursue further in its proposed mitigations or alternative plans. However, because PG&E did not identify these mitigations, it is difficult to determine what other mitigations PG&E has considered. For greater transparency, PG&E should compile a list of these considered mitigation efforts, and include as an appendix to their RAMP filing. For such a list, PG&E should list the high level categorizations of mitigations it identified and considered, and does not necessarily have to go into detail of the reason for such exclusion.²²

5. Consistency of Reported Cost and RSE

PG&E should maintain consistency between the reported cost for the mitigation plans and RSE values in its visual representations. In its application, each chapter has a bar chart comparing the cost and RSE of the three different mitigation plans (proposed mitigation, alternative 1, and alternative 2).²³ However, the costs and RSEs shown in this chart are calculated over different timeframes: PG&E calculates the RSE for a mitigation plan from 2017 to 2022, but the cost shown in the bar chart is the total cost for a mitigation plan from only 2020 to 2022. For example, PG&E represents the Distribution Overhead Conductor Primary's proposed plan with an RSE of 0.538 and a cost of \$51,960,000. However, the total cost for the proposed plan summed from 2017 to 2022 is actually

²² For example, see PG&E's Chapter 9 – Distribution Overhead Conductors' description of 3 mitigation measures considered but not implemented for the 2020-2022 time period.

²³ See for example, Figure 1-3 in Chapter 1. Each chapter with proposed mitigations presents a similar chart.

\$86,600,000.²⁴ PG&E should be consistent in its visual representation of the costs and RSEs to reflect the true relationship between the two.

IV. PG&E RISKS

A. Transmission Pipeline Rupture with Ignition

The risk of Transmission Pipeline Rupture with Ignition has a Tail Average MARS of 37.62, ranking it 15th among all of PG&E's identified risks. The proposed total spend from 2017 to 2022 is \$3,259,252,592. This risk is defined as an unintended release of gas on a transmission pipeline that leads to ignition including events on transmission pipelines within gas storage facilities.

As mentioned previously in General Comments Section A.6, PG&E should have greater granularity in its exposure unit of number of pipeline miles. Currently, PG&E makes “no distinction” between pipe segments within its model.²⁵ As mentioned by the Commission's Safety and Enforcement Division (SED) Report, “pipeline diameter and operator pressure [as well the as the presence of high consequence areas], play a significant role in determining the potential [risk] consequence”.²⁶

Basing the metric on the number of leaks on transmission pipelines, rather than the number of ignitions, is appropriate. By collecting data on the precursors to transmission line ignition, PG&E should also collect data on near misses. Because of the low probability of transmission pipeline ruptures with ignition, this risk event has very little PG&E-specific data, creating difficulties in determining its level of risk. PG&E should holistically consider near-misses in order to bolster its data set for this risk event, and better determine level of risk.

This risk has a Tail Average MARS rank of 15th. In addition, its proposed mitigations have one of the lowest RSEs of the 22 risks. This risk has had the largest mitigation budget, and its alternative plans only considered expanding the level of mitigation rather than scaling down scope, despite rejecting these alternatives due to

²⁴ Copy of Tabulated Risk and mitigations outcomes_PGandE 2017 RAMP.xlsx

²⁵ PG&E RAMP Report at p. 1-3.

²⁶ SED Report at p. 16.

“considerations for cost”,²⁷ and that all of its mitigation efforts have low RSEs.²⁸ Portions of this budget may be required to satisfy regulatory compliance, and thus may be impossible to scale down. However, PG&E should analyze the following:

- a. What it would look like to deprioritize this risk and shift funds to more cost-effective forms of risk mitigation.
- b. Justify the risk’s allocated mitigation budget, and, if this justification is not due to the inability to scale down the mitigations because of regulatory requirements, then provide an explanation of why the true cost effectiveness of this risk’s mitigation plan is especially not captured by the model’s RSE values.

B. Failure to Maintain Capacity for System Demands

The risk of Failure to Maintain Capacity for System Demands has a Tail Average MARS of 325.34, ranking it 3rd among all risks. However, the Expected Value MARS of 40.94 is 9th among all risks.²⁹ The proposed total spend from 2017 to 2022 is \$460,169,278. This risk is defined as failure to meet gas demand capacity due to operating restrictions when performing gas transmission safety projects. It does not include failure to meet gas demand capacity due to other reasons.

PG&E decided to categorize this type of event as a standalone risk rather than simply aggregating it as one factor for multiple other risks. While this risk is much more specific than its counterparts, its high Tail Average MARS justifies its separate inclusion. Furthermore, the current lack of quantification of this risk’s gas surge back, hypothermia, and homeowner property damage,³⁰ implies its consequences may be even greater than its current valuation.

However, caution must be taken to ensure that the disaggregation of this risk into its own chapter does not cause this risk to not be accounted for when considering measures that cause it. Currently, in-line inspections and hydrostatic pressure testing of pipelines,

²⁷ PG&E RAMP Report at pp. 1-19 to 1-20.

²⁸ From Table 1-3, the highest RSE of PG&E’s proposed mitigations for this risk is 0.0152. All other risks that have a proposed mitigation have at least one measure with an RSE of 0.047 or greater.

²⁹ SED Report at p. 41.

³⁰ PG&E RAMP Report at p. 2-14.

which are mitigation measures for other risks, do not factor into their RSE their influence in increasing the probability of failure to maintain capacity.³¹ This prevents these measures from having their true risk reduction, and thus true cost effectiveness, captured. In extreme cases, these mitigation measures could actually have a net increase in risk, if the risk increase from failure to maintain capacity is greater than the risk decrease from improved pipeline integrity from these measures. Therefore, it is imperative that the risks of this chapter are discounted from the benefits of the mitigation measures that cause it.

Given that many of the non-reliability consequences of this risk are a result of human behavior (i.e. using outdoor cooking equipment indoors), PG&E should consider implementing public awareness as a mitigation measure for this risk. This seems especially prudent considering the high RSE of public awareness as a mitigation in other chapters³².

ORA's comments on this section's alternate plans are reflected in General Comments Section C.2 above.

Due to the lack of current data pertinent to this risk, ORA's comments on managing uncertainty are reflected in General Comments Section A.4 above.

C. Measurement And Control Failure – Release of Gas With Ignition Downstream

The risk of Measurement and Control Failure – Release of Gas with Ignition Downstream has a Tail Average MARS of 12.07, ranking it 20th among all risks. The total spend proposed from 2017 to 2022 is \$583,120,367. This risk is defined as events at a measurement and control facility that cause an unintended release of gas downstream of the facility that do not lead to ignition. Cases of ignition are covered instead in Chapters, 1, 5 and 7.

³¹ From Appendix D, p.52: ORA DR-02, Question 3: "ORA's understanding is correct. The measures of In-line Inspection and Hydrostatic Pressure Testing do not factor in the effect of these measures increasing the risk of failure to meet capacity for system demands..."

³² Namely, Chapter 9 – Distribution Overhead Conductor Primary, and Chapter 10 – Transmission Overhead Conductor, which have RSEs of additional public awareness of 21.133 and 6.628 respectively.

Additionally, Chapter 1 – Transmission Pipeline Rupture with Ignition, Chapter 7 – Release of Gas with Ignition on Distribution Facilities – Non-Cross Bore, Chapter 8 – Natural Gas Storage Well Failure – Loss of Containment With Ignition at Storage Facility list public awareness as a control.

PG&E's metric for this risk is the number of large overpressure events, regardless of whether these overpressure events cause a release of gas and ignition downstream. As mirrored by ORA's comments in PG&E Risks Section A, this use of a broader metric allows for the capturing of near-miss events as well as actual risk events. These near miss events are especially important in holistically evaluating the level of risk for events that are infrequent and thus have little data.

In light of the fact that incorrect operations are estimated to be the most frequent driver of this risk,³³ PG&E should ensure continued coordination of this risk with the cross-cutting risk Skilled and Qualified Workforce.

ORA's comments on this chapter's alternative plans are reflected in General Comments Section C.2 above. Furthermore, Alternative Plan 2 was not chosen despite a higher RSE due to "higher asset age," which would "increase the probability that it will fail."³⁴ This is an instance of where the current short time frame of PG&E's RAMP model does not properly reflect the benefits of long term expenditures within its RSEs. ORA's comments on the need of PG&E's RSE calculations to better quantify the benefits of long-term expenditures are reflected in General Comments Section B.1, above.

Due to PG&E's current lack of data pertinent to this risk, as evidenced by only 5 events industry-wide between 2010-2016 and no events of this nature in the entire history of PG&E,³⁵ ORA's comments on this chapter's need to manage uncertainty are reflected in General Comments Section A.4, above.

Given that this risk has one of the smallest Tail Average MARS, and that over half of the Tail Average MARS for this risk stems from its Trust attribute – a risk attribute ORA discusses in General Comments Section A.1 – PG&E should consider whether to keep this risk in its future RAMP filings, or whether to remove and replace the risk in a manner as reflected in General Comments Section A.3.

³³ PG&E RAMP Report at p. 3-3.

³⁴ PG&E RAMP Report at p. 3-16.

³⁵ PG&E RAMP Report at p. 3-4.

D. Measurement And Control Failure – Release of Gas With Ignition At Measurement and Control Facility

The risk of Measurement and Control Failure – Release of Gas with Ignition at Measurement and Control Facility has a Tail Average MARS of 17.49, ranking it 18th among all risks. The total spend proposed from 2017 to 2022 is \$380,070,892. This risk is defined as an unintended release of gas at a measurement and control facility that leads to ignition.

PG&E's metric for this risk is the number of reportable incidents, regardless of whether these incidents lead to ignition. As noted by ORA's comments in PG&E Risks Section A, this use of a broader metric allows for the capturing of near-miss events as well as actual risk events. These near miss events are especially important in holistically evaluating the level of risk for events that are infrequent and thus have little data. However, PG&E should consider also incorporating overpressure events, regardless of whether there is a release of gas, to make the metrics consistent with the similar Measurement and Control Failure – Release of Gas with Ignition Downstream risk in Section C.

ORA's comments on this chapter's alternative plans are reflected in General Comments Section C.2 above.

Given that this risk has one of the smallest Tail Average MARS, and that over half of the Tail Average MARS for this risk stems from its Trust attribute – a risk attribute ORA expresses concerns about in General Comments Section A.1 – PG&E should consider whether to keep this risk in its future RAMP filings, or whether to remove and replace the risk in a manner as reflected in General Comments Section A.3.

E. Release of Gas With Ignition on Distribution Facilities – Cross-Bore

The risk of Gas with Ignition on Distribution Facilities – Cross-Bore has a Tail Average MARS of 28.46, ranking it 16th among all risks. The total spend proposed from 2017 to 2022 is \$376,815,080. This risk is defined as ignition of gas in distribution pipelines due to cross boring, i.e. ignition caused by gas distribution pipelines intersecting and thus puncturing into other underground lines.

PG&E’s metric for this risk is tied to the overall number of cross bores, regardless of whether these cross bores lead to ignition. As mirrored by ORA’s comments in PG&E Risks Section A, this use of a broader metric allows for the capturing of near-miss events as well as actual risk events. These near miss events are especially important in holistically evaluating the level of risk for events that are infrequent and thus have little data.

Besides the mitigation measures proposed by PG&E for this risk, PG&E should consider outreach efforts with water utilities and permitting agencies as a possible mitigation, if it has not already done so. While even the water utility owners of water pipes will most likely not know the exact location of these pipelines without executing a “locate and mark,” these utilities may be able to provide maps that will allow PG&E to plan pipeline construction routes and prioritize locations for camera inspection to better mitigate the frequency of cross-bores.

Much of the data for consequences for this risk are based on industry averages of similar but potentially consequentially different events, rather than on consequence data specific to this risk event. For example, the estimation for the fatality consequence is based on an industry average for number of fatalities given ignition due to any cause.³⁶ Cross-bore specific data should be incorporated as it becomes available.

Due to PG&E’s current lack of data pertinent to this risk, as evidenced by the fact that there have been 4 injuries and 2 fatalities in regards to this risk industry-wide since 1976.³⁷ ORA’s comments on this chapter regarding the need to manage uncertainty are reflected in General Comments Section A.4 above.

Given that this risk has one of the lowest Tail Average MARS, and that over half of the Tail Average MARS for this risk stems from its Trust attribute – a risk attribute ORA expresses concerns about in General Comments Section A.1 – PG&E should consider whether to keep this risk in its future RAMP filings, or whether to remove and replace the risk in a manner as reflected in General Comments Section A.3.

³⁶ See PG&E work paper “05 - DMSCB - Distribution cross-bore - PGandE 2017 RAMP” Tab “DMSCBInput” Row 48.

³⁷ PG&E RAMP Report at p. 5-1.

F. Compression and Processing Failure – Release of Gas With Ignition At Manned Processing Facility

The risk of Compression and Processing Failure – Release of Gas with Ignition at Manned Processing Facility has a Tail Average MARS of 39.86, ranking it 14th among all risks. The total spend proposed from 2017 to 2022 is \$120,133,419. This risk is defined as an unintended release of gas at a compression or processing facility that leads to ignition.

PG&E's metric for this risk is the number of reportable incidents, regardless of whether these incidents lead to ignition. As mirrored by ORA's comments in PG&E Risks Section A, this use of a broader metric allows for the capturing of near-miss events as well as actual risk events. These near miss events are especially important in holistically evaluating the level of risk for events that are infrequent and thus have little data.

PG&E is already required by federal pipeline regulations³⁸ to increase public awareness of this risk. However, PG&E makes no mention of such a measure for public awareness anywhere in this chapter, despite listing public awareness as a control, and additional public awareness as a mitigation, in several of its other chapters.³⁹ PG&E should add public awareness as a control for this risk, and consider increased public awareness as a mitigation measure.

ORA's additional comments on this chapter's alternative plans are reflected in General Comments Section C.2 above.

PG&E lists sensitivity analysis as a next step for modeling this risk. As mentioned in ORA's General Comments Section A.4, sensitivity analysis is a method to help manage uncertainty, as is the case with the lack of data pertinent to this risk. PG&E should pay attention particularly to performing sensitivity analysis on the fatality consequence. This consequence makes up roughly one-sixth of the tail average MARS for this risk, yet all fatalities in regards to this risk have come from a single incident.

³⁸ Title 49 Code of Federal Regulations § 192.616.

³⁹ Namely, Chapter 1 – Transmission Pipeline Rupture with Ignition, Chapter 7 – Release of Gas with Ignition on Distribution Facilities – Non-Cross Bore, Chapter 8 – Natural Gas Storage Well Failure – Loss of Containment With Ignition at Storage Facility, Chapter 9 – Distribution Overhead Conductor Primary, and Chapter 10 – Transmission Overhead Conductor (TOHC).

G. Release of Gas with Ignition on Distribution Facilities – Non-Cross-Bore

The risk of Release of Gas with Ignition on Distribution Facilities – Non-Cross-Bore has a Tail Average MARS of 188.84, ranking it 9th among all risks. The total spend proposed from 2017 to 2022 is \$147,037,344. This risk is defined as an unintended release of gas on a distribution pipeline that leads to ignition.

As mentioned previously in General Comments Section A.6, PG&E should have greater granularity in its exposure unit of number of pipeline miles. Currently, PG&E aggregates mains and service lines, and does not distinguish for pipeline diameter, age, operating pressure, material type, or nearby population density.⁴⁰ This could be problematic for vintage brittle PVC and Aldyl-A pipe that may have elevated risk,⁴¹ or for pipelines that are in high population density regions. PG&E already lists pipeline replacement program as a control,⁴² which implies that PG&E already believes there are different levels of risk based on pipeline characteristics. Greater granularity of this risk's exposure unit could better quantify the differing levels of risk from different pipe characteristics, and thus inform accelerating or decelerating this pipeline replacement control.

Furthermore, PG&E currently calculates its service pipeline miles based on an estimated average length of pipe for each service, rather than having actual measurements of each service. If PG&E obtains greater resolution data in the future, such data should be incorporated in order to better estimate PG&E's level of risk exposure.

A significant portion of the drivers for this risk fall under "other" categories. PG&E should consider whether to better categorize these "other" driver, or, if the drivers are unknown, methods to better trace the source of these drivers. The current generality of these "other" categories creates uncertainty of the frequent drivers of this risk. Because

⁴⁰ PG&E Work Paper "07 - DMS - Distribution non-cross-bore – PG&E 2017 RAMP" Tab "DMSInput" Column O simply sums mains and service lines. Furthermore, nowhere are there inputs for type of distribution pipe.

⁴¹ PG&E RAMP Report at p. 7-9, "The Aldyl-A Pipeline Replacement Program focuses on plastic materials of pre-1985 vintage that have a susceptibility to slow crack growth".

⁴² *Id.*

mitigation measures are tied to the drivers or consequences they impact, this in turn creates uncertainty in the effectiveness of the mitigation measures.

PG&E has significant PG&E-specific for this risk. ORA's recommends that PG&E give greater weight to data specific to their own facilities, as reflected in General Comments Section A.8.

ORA's comments on this chapter's alternative plans are reflected in General Comments Section C.2 above.

H. Natural Gas Storage Well Failure Loss of Containment With Ignition at Storage Facility

The risk of Natural Gas Storage Well Failure Loss of Containment with Ignition at a Storage Facility has a Tail Average MARS of 12.68, ranking it 19th among all risks. The total spend proposed from 2017 to 2022 is \$402,406,000. However, because the sole proposed mitigation measure is for baseline assessments only, the total spend on direct risk reduction is \$0. This risk is defined as unintended release of gas on a natural gas storage well that leads to ignition. It does not include non-well assets of the storage facility, or facilities not under full PG&E ownership (i.e. Gill Ranch Storage Field).

PG&E currently defines its exposure unit as the number of wells in operation. However, as reflected in ORA's General Comments Section A.6, greater granularity of exposure units may be necessary to fully capture varying of risk of individual components. PG&E should consult with subject matter experts on whether different characteristics of its wells can cause each individual well to have significantly different levels and type of risk. Thus, PG&E should consider having greater granularity in its exposure for this risk accordingly.

PG&E states that its performance metric for this risk will be defined following baseline assessments. PG&E should ensure the metric chosen is both representative and is general enough to be able to incorporate the consideration of near misses, as PG&E has done in many other risk chapters.

Furthermore, PG&E's baseline assessments are effectively foundational work, yet they are not identified as such. An RSE for baseline assessments is also inconsistently

provided,⁴³ despite no RSE being provided for other foundational work. This is because foundational work without additional mitigations as informed by such foundational work, does not reduce risk. Therefore, it is therefore unclear what mitigation efforts would follow these baseline assessments that would generate the RSEs provided for this chapter.

PG&E should thus clearly define what controls and mitigations are foundational work, and strive for consistency in analyzing such work. If other mitigations are anticipated to stem from foundational work, PG&E should be transparent of their nature so that their generated RSEs can be better analyzed.

PG&E also should be transparent of how regulations of the Department of Conservation's Division of Oil, Gas, and Geothermal Resources (DOGGR) impact PG&E's control and mitigation measures.

Due to the infrequent nature of this risk, ORA's comments on this chapter's need to manage uncertainty are reflected in General Comments Section A.4 above.

I. Distribution Overhead Conductor Primary

The risk of Distribution Overhead Conductor Primary has a Tail Average MARS of 824.35, ranking it 1st among all risks. The total spend proposed from 2017 to 2022 is \$ 86,600,000. PG&E describes the risk as failure of public contact with an energized distribution primary conductor. The risk accounts for contact with intact conductors (either directly or via an object), and contact with energized conductors from wire down events. Vegetation represented the greatest risk driver for Distribution Overhead Conductor – Primary (DOCP), accounting for 42% of the wire down events. Majority of the Tail Average MARS is due to reliability and safety – fatalities consequences. Strengths of this chapter include PG&E using PG&E historical data for wire down events and consequences (safety – injuries and fatalities), and variation between proposed mitigation plan, alternative 1 and alternative 2.

PG&E does not explain the difference between the number of controls and mitigation in place until 2019 and the proposed mitigation plan. PG&E reports 11 risk

⁴³ PG&E's RAMP Report Table 8-6, at p. 8-14. However, Excel file "Copy of Tabulated Risk and Mitigations outcomes_PGandE 2017 RAMP", sheet "By Risk" shows no RSE for this mitigation measure.

controls and 4 mitigations for 2017-2019.⁴⁴ However, the proposed mitigation plan only has two mitigations listed: Additional Public Awareness Outreach and Overhang Clearing. PG&E does not explain why some of the current controls are no longer part of the proposed mitigation plan even though there is a wide range of mitigations targeting the various risk drivers. Nor is there an explanation for the changes in mitigations in place for 2016-2019 and a proposed mitigation plan. For example, Overhead Conductor Replacement Program is listed as a risk control.⁴⁵ This control is not continued. ORA recommends PG&E provide explanations for discontinuation of mitigation plans. PG&E does not quantify the effectiveness, in terms of RSE, of mitigations that have been or are currently in place.⁴⁶ While ORA does not necessarily advocate that PG&E develop RSEs for current mitigations, some form of analysis of the effectiveness of current and past mitigations would make PG&E's decisions to continue or discontinue programs more transparent. Comments on clarity and transparency as described in General Comments Section D apply for this chapter.

ORA is also concerned with the lack of diverse mitigations in the proposed mitigation plan. The proposed mitigation only addresses safety – injuries and fatalities, and three drivers: third-party (contact with intact), vegetation, and third party (wire down).⁴⁷ It does not address any equipment failure risk, which, when summed across the three breakdowns represents 31% of the wire down events.⁴⁸ Equipment failure is only addressed in alternative plan 1 and 2. ORA recommends that PG&E account for long term benefits of mitigations, as mentioned in Section III C. PG&E states “the alternative mitigation plan was not viable based on the low expected RSE and the need for the program to replace conductor related to other prioritization factors”. Accounting for the long term benefits of Targeted Conductor Replacement (Mitigation 6) could potentially affect the total RSE calculated for alternative mitigation program.

⁴⁴ PG&E RAMP Report at pp. 9-15, 9-18

⁴⁵ PG&E RAMP Report at Table 9-1

⁴⁶ Appendix D at p. 53: ORA DR-02, Question 4.

⁴⁷ PG&E RAMP Report at Table 9-3.

⁴⁸ PG&E RAMP Report at p. 9-6.

PG&E indicates data collection through various inspections as part of risk controls, such as C6 and C7. It is unclear how this data is used to further reduce risk since the proposed mitigation plan does not indicate usage of these data. Similarly, ORA also agrees with SED that PG&E is developing tools for risk mitigation but does not factor them into risk analysis for the mitigation plans.⁴⁹ ORA recommends that PG&E discuss how data collected and risk mitigation tools will reduce the respective risks and how it is used in the mitigation plans.

J. Transmission Overhead Conductor (TOHC)

The Transmission Overhead Conductor risk has a Tail Average MARS of 227.50, ranking it 7th among all risks. The total spend proposed plan from 2017 to 2022 is \$300,579,881. This risk is defined as public contact with transmission wires, either energized overhead wires, or wires that have been downed. It does not include the potential consequence of wildfires due to these wires, nor the risk of employee or contractor contact with such wires. PG&E specifically mentions that “Some lines have a higher risk of failure than others. For example, lines have a higher likelihood of wire down when built near dense vegetation or when constructed in areas that experience more extreme weather.”⁵⁰ Thus, ORA’s comments on need for granularity of exposure units as reflected in General Comments Section A.6 appears more than prudent.

Alternative Plan 1 was not chosen despite a higher RSE, in part, because “some RSE calculations are understating the benefits for higher cost mitigations, which are inappropriately deflating the associated RSE for the mitigation. For example, Additional Overhead Conductor Replacement [which was chosen for the proposed plan, but not for Alternative Plan 1]”.⁵¹ This is an instance of where the current short time-frame of PG&E’s RAMP model does not properly reflect the benefits of long term expenditures within its RSEs. ORA’s comments on the need of PG&E’s RSE calculations to better quantify the benefits of long term expenditures are reflected in General Comments Section B.1 above.

⁴⁹ SED Report at p. 76.

⁵⁰ PG&E RAMP Report at p. 10-5.

⁵¹ PG&E RAMP Report at p. 10-24.

Due to PG&E's data for the fatality consequence from this risk stemming from 3 instances of fatalities, and that this fatality consequence is quite significant in that it makes up over a third of the Tail Average MARS score for this risk, ORA's comments on this chapter's need to manage uncertainty are reflected in General Comments Section A.4 above.

ORA supports the separation of this risk into wire down and 3rd party contact categories, due to the lack of interdependence between the two.

K. Wildfire

The Wildfire risk has a Tail Average MARS of 257.58, ranking it 5th among all risks. The total spend proposed plan is \$797,683,138 from 2017 to 2022. The proposed plan results in a risk score reduction of 76.97 MARS units, and a total RSE of 0.097 MARS Units/million dollars spent. This risk is defined as PG&E assets initiating a wildland fire that endangers public or private property, sensitive lands, and/or leads to long-duration service outages.

This chapter has the strength of drawing on a large body of data regarding wildfires in California to inform its estimate of the risk consequences and mitigation effectiveness, rather than relying solely on SME data. In addition, ORA supports the use of multipliers⁵² in calculating mitigation effectiveness in areas with increased fire risk or vegetation contact, and encourages developing further granularity in future iterations of the model.

The alternatives presented in this chapter exemplify the issues with the proposal of alternatives in this report. Contact with vegetation is the most significant risk driver of wildfire ignitions initiated by PG&E assets in the Fire Index Area.⁵³ Yet, Alternative 1 excludes mitigations like "Fuel Reduction and Powerline Corridor Management" and "Overhang Clearing" that aim to reduce the risk of ignitions caused by contact with vegetation risk driver.⁵⁴ Unsurprisingly, this alternative was found to not provide sufficient

⁵² Some of the figures shown in the "Justifications" on WP 11-5 to WP 11-30 are incorrect. Per ORA's conversation with PG&E witnesses on April 9, 2018, it is ORA's understanding that PG&E will submit errata with corrected multipliers.

⁵³ PG&E RAMP Report, Risk Bowtie at p. 11-6.

⁵⁴ PG&E RAMP Report at p. 11-18.

risk reduction.⁵⁵ Alternative 2, on the other hand, includes all of the mitigations, including those with low RSEs, like Targeted Pole Replacement, and relatively high costs, namely Targeted Underground Conversion. This plan was rejected because of its high cost, and relatively low improvement in risk mitigation compared to the proposed plan. Both alternatives are clearly suboptimal and do not demonstrate sufficient effort to propose alternative plans that balance risk reduction and cost-effectiveness even though reasonable alternatives exist. For example, an alternative plan that replaces Targeted Conductor Replacement with Targeted Underground Conversion, or includes Targeted Underground Conversion would be a preferable alternative than the alternative plans presented since it includes the mitigations with the highest RSEs, and excludes mitigations with particularly low RSEs.

The fuel reduction and overhang clearing mitigations in this chapter are good candidates for the comments in Section III regarding the consideration of interactions between mitigations with overlapping exposures and benefits. Both fuel reduction and overhang clearing will take place in Tier 3⁵⁶ fire risk areas and presumably, fuel reduction will somewhat reduce the need for – and the benefit of – overhang clearing in those areas. Thus, separately calculating the RSEs for these mitigations likely leads to an overestimation of the overall RSE.

The Wildfire Risk shares drivers and proposed mitigations – Overhang Clearing and to an extent, Targeted Conductor Replacement - with the Distribution Overhead Conductor Risk. Such overlap presents the opportunity for optimization of mitigations across risks, since a single mitigation that addresses multiple risks may be desirable even though that mitigation's RSE for individual risks does not warrant it serving as a proposed mitigation. PG&E does not take this benefit into account in determining mitigation RSEs, and it is unclear to the extent to which PG&E implicitly accounted for the ability of the Overhang Clearing and Targeted Conductor Replacement to mitigate both wildfire and distribution overhead conductor risk independently of its RSE calculation. PG&E should consider an

⁵⁵ PG&E RAMP Report at p. 11-22.

⁵⁶ Tier 3 fire-threat areas depict areas where there is an extreme risk (including likelihood and potential impacts on people and property) from utility associated wildfires on the CPUC Fire-Threat map.

explicit and quantitative method of considering the benefits of mitigations that address multiple risks.

ORA supports separating transmission and distribution risks to reflect the higher likelihood of ignitions occurring on distribution lines on a per-mile basis than on transmission lines, as well as the different drivers underlying transmission and distribution-caused ignitions.

Finally, this chapter raises an interesting issue regarding how to estimate the risk for phenomena that are changing over time. The increase in both the frequency and consequence of wildfires, driven by factors including increasing wildland urban interface development and climate change,⁵⁷ suggests that it is worth considering as a next step how past data may not be entirely representative of future events, and whether PG&E should explicitly consider this factor in predicting future risk levels.

L. Nuclear Core Damaging

The Nuclear Core Damaging risk has a Tail Average MARS of 6.65, ranking it the second lowest risk among all risks in the report. There are no proposed mitigations for this risk, and therefore the proposed total spend from 2017 to 2022 is \$0.

PG&E's The analysis of this risk is unique in that due to regulatory requirements by the NRC, there is an identified risk threshold – defined in terms of frequency – for core damage events. As noted in Section III, this is a desirable characteristic because it allows others to evaluate whether a mitigation plan mitigates a sufficient amount of risk. However, fulfilling or exceeding a regulatory requirement is not a justification for not considering further risk reducing mitigations. PG&E should evaluate or support the reasonableness of the risk tolerance independently of the regulatory requirement through an analysis of whether there are any further mitigations that would be cost-effective or low-hanging fruit.

M. Hydro System Safety - Dams

The Hydro risk has a Tail Average MARS of 100.89, ranking it 12th among all risks. The total spend proposed is \$57,344,398 from 2017 to 2022. This risk is defined as

⁵⁷http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Safety/CalFire%20enBanc_sapsis.pdf (Presented at the CPUC Fire Safety and Utility Infrastructure En Banc)

the failure of a large PG&E-owned dam failure that is located in PG&E territory with the potential to cause significant threats to safety and extensive environmental damage.⁵⁸

PG&E’s analysis focuses on the 20 dams that PG&E has categorized as “high consequence.” ORA supports PG&E’s proposed next steps to expand its analysis to include all PG&E-owned dams.

The seepage driver is attributed to just 1% of the overall frequency of a high consequence dam, yet a significant portion of the investment planned is for seepage mitigation projects. This suggests that more granular and PG&E-specific inputs are necessary for properly assessing the seepage driver.

ORA supports SED’s recommendation that PG&E incorporate findings from the Independent Forensic Team Report on the Oroville Dam in its future analyses.

Finally, Figure 13-3 in this chapter incorrectly depicts the cost of Alternative Plan 2.⁵⁹

N. Contractor Safety

The Contractor Safety risk has a Tail Average MARS of 181.48, ranking it 10th highest among all risks. The total spend proposed is \$8,279,123 from 2017 to 2022. This risk is defined as “the failure to identify and mitigate occupational exposures that may result in a contractor injury or illness”,⁶⁰ though PG&E subsequently defines it as the “failure to implement pre-qualification and field oversight procedures.”⁶¹ In general, this chapter does not seem to have a clear and consistent discussion of what the actual risk event is. For example, the risk bowtie confusingly suggests that “over exertion and bodily reaction” and “contact with objects and equipment” are drivers for the “failure to fully implement pre-qualification and field oversight procedures” that may result in contractor safety consequences.

⁵⁸ PG&E RAMP Report at p. 13-2.

⁵⁹ ORA understands that PG&E will file errata to correct this and appreciates PG&E’s willingness to acknowledge and correct such errors.

⁶⁰ PG&E RAMP report at p. 14-1.

⁶¹ PG&E RAMP report at p. 14-4.

There were multiple aspects of the way this risk was presented that made it difficult to evaluate. The way the risk bowtie is presented differs from that of other chapters in that the risk is conflated with its consequences. It is not clear that this holds any advantages since both risks have the same drivers, albeit with different frequencies. This is in contrast with the “Cyberattack” chapter, where the overall risk could be distinguished as two fundamentally different risks. Consistency in the format of the bowtie would be preferable, especially since the breaking out of the risk by consequence does not seem to affect the rest of the analysis in any way, in that all mitigations are targeted to address both contractor fatalities and injuries.

This chapter was also particularly difficult to understand in terms of understanding how the driver frequencies and total risk event frequency were derived. While the model spreadsheet shows some of the information used to calculate the frequencies, it does not show all of the steps, and it seems to include data that was not used in calculating the frequency,⁶² making it very confusing to follow.

The mitigation plans are also presented in a non-intuitive manner. Individual mitigations are grouped into categories. M11: Contractor Process Improvements, for example, consists of five mitigations. However, there are three versions of M11 (A, B, and C) which consist of different sets of mitigations. This bundling of mitigations into different versions of a bundle of mitigations makes it much more difficult to interpret which mitigations each mitigation plan consists of. For example, in Table 14-4, it is difficult to tell what it means to include M11A, which includes all five mitigations, but exclude M11B or M11C, which are subsets of M11A. It may make sense to group mitigations into categories or a single mitigation, if all of those mitigations will be treated as a single unit. If it is necessary to present different versions of a bundled mitigation for alternative proposals, as is the case with M11, the mitigation should just be broken out into the mitigations that it is composed of for transparency and clarity. Both alternatives for this chapter are rejected on the grounds that it is unclear whether it was possible for Corporate Safety and Health Department at PG&E to make changes to the One PG&E Occupational

⁶² See Appendix D at pp. 50-51: ORA DR-02, Question 2, which includes steps in the calculation that PG&E did not show in its Model Excel file.

Health and Safety Plan (One PG&E Plan) without disrupting other aspects of the plan, which had been created with input from the different Lines of Businesses (LOBs).⁶³ This reveals a disconnect between the RAMP analysis and PG&E's actual structures and processes for implementing risk mitigations. The fact that PG&E had already developed the One PG&E Plan before conducting the RAMP analysis should not preclude the consideration of alternatives that may change or improve the plan. In the future, PG&E should work towards truly incorporating RAMP into their decision-making process and integrating the LOBs involved with an enterprise risk.

Finally, as noted in the SED report, there is an explicit exclusion of motor vehicle incidents from the contractor safety risk to avoid overlap with the Motor Vehicle Safety Risk. Yet, PG&E proposes review of contractors' DMV incident records and specification of driver training as a mitigation. PG&E should be consistent in defining the scope of its risks and mitigations.

O. Employee Safety

The Employee Safety risk has a Tail Average MARS of 263.01, ranking it 4th highest among all risks. The total spend proposed is \$7,465,234 from 2017 to 2022. This risk is defined as "the failure to identify or mitigate occupational exposures that may result in an employee injury or illness that is fatal, life threatening, or life altering."

The structure of this chapter is similar to that of contractor safety, in that the risk is divided into events that result in fatalities and events that result in injury or illness even though the two events do not seem fundamentally different enough to warrant such a division. As with the Contractor Safety chapter, there are also issues with the drivers lining up with the risk identified in the risk bowtie, and the risks being conflated with their consequences.

Alternative 1 for this risk involves extending the timeline for development and implementation of the Safety Management System. As noted in Section III, alternatives based on a different pace of work are not complete alternatives. When discussing Alternative 1, PG&E notes "Extending the timeline, while still addressing the risk drivers,

⁶³ Appendix D at p. 49: ORA DR-02, Question 1.

is not required for the development of the program or establishing the foundation for successful implementation”.⁶⁴ Save for the benefit of “cost smoothing over a longer timeframe”⁶⁵ – which is always a benefit of extending the timeline of implementation – there seems to be no reason for considering a longer timeframe for implementation.

The explanation for why PG&E did not choose Alternative 2 contradicts the calculated RSE. PG&E rejects Alternative 2 because of its “increased cost and decreased risk spend efficiency.”⁶⁶ Yet, according to Table 15-5, Alternative 2 has a *higher* RSE than the proposed mitigation – 0.21 compared to 0.15. PG&E seems to suggest that this may be because Alternative 2 has a higher risk reduction in the 3 years over which the RSE is calculated but lower risk reduction in the long term, but does not explicitly explain this contradiction, making their choice confusing and difficult to evaluate.

In addition, ORA agrees with the SED report’s comment that PG&E’s description of the Safety Management System is too high level and, considering that it is the only mitigation proposed in this chapter, PG&E should provide a more detailed explanation of the program and how it addresses the risk.

P. Motor Vehicle Safety

The Motor Vehicle Safety risk has a Tail Average MARS of 214.3, ranking it 8th highest among all risks. The total spend proposed is \$2,917,299 from 2017 to 2022. This risk is defined as “the failure to identify and mitigate motor vehicle incident exposures that may result in serious injuries or fatalities”. As noted by SED, the risk definition is unclear and does not seem to align completely with the mitigations which suggest that the risk should more simply be defined as motor vehicle accidents rather than motor vehicle “incident exposures”.⁶⁷

This chapter has the strength of drawing on several large datasets, including PG&E’s own data and national data, in quantifying the frequency and consequences of the Motor Vehicle Safety risk. PG&E has 18 controls already in place to address this risk. The

⁶⁴ PG&E RAMP Report at p. 15-13.

⁶⁵ PG&E Work Papers at p. WP 15-5.

⁶⁶ PG&E Work Papers at p. WP 15-6.

⁶⁷ SED Report at p. 119.

number of controls makes it difficult to evaluate whether there any interactions between current controls and the proposed mitigations. As noted in Section III, PG&E should attempt to consider whether there are any synergies or overlaps in evaluating the mitigation RSEs.

As noted in Section III, mitigations should only be proposed if they are feasible. In this chapter, PG&E proposes “Emerging Incident Technology” and “Emerging Impact Reduction Technology” as mitigations with the assumption that they will offer risk reduction similar to Vehicle Safety Technology and airbags, respectively, but notes that that there are no current technologies on the market that meet that criteria.⁶⁸ PG&E also did not evaluate any specific technologies.⁶⁹ ORA agrees with SED that consideration of technologies that do not yet exist is not an appropriate option, and should instead be considered as a potential next step.⁷⁰

Q. Lack of Fitness for Duty Program Awareness

The Lack of Fitness for Duty Program Awareness risk has a Tail Average MARS of 50.43, ranking it 13th highest among the 22 risks. The total spend proposed is \$31,650,372 from 2017 to 2022. This risk is defined as “PG&E people leaders failing to identify and act upon observed behaviors which indicate an employee may be unable to work safely.”⁷¹ As noted in the SED report, the way that the risk is defined does not align with the mitigations that PG&E has identified. Even though the risk is framed as an issue of lack of awareness of fitness for duty concerns, three out of the four proposed mitigations seem to address Fitness for Duty itself. Only the Mandatory Fitness for Duty training for All People Leaders mitigation seems to address the risk as defined, while the Redesigned Time-Off Policy and Voluntary Plan, telemedicine kiosks, and on-site clinics seem intended to improve employees’ fitness for duty directly rather than people leaders’ awareness of fitness for duty. PG&E should clarify the definition of the risk and be consistent in the definition. The way this risk in general is defined is confusing since the risk event seems

⁶⁸ PG&E RAMP Report at p. 16-16.

⁶⁹ Appendix A at p. 5: ORA DR-01, Question 5.

⁷⁰ SED Report at p. 120.

⁷¹ PG&E RAMP Report at Figure 17-4.

more like a risk driver than a risk in and of itself, while the risk driver, “events with adverse outcomes,” seems like it should be the risk. This risk makes a good candidate for a cross-cutting risk or for being absorbed as a risk driver into the associated stand-alone risks since lack of fitness for duty could be considered a risk driver for a variety of other risks included in the report.

PG&E offers unsatisfactory explanations for its rejection of the alternative proposals. Instructor led training offers the highest RSE by far of any of the proposed mitigations. Yet, PG&E rejects both alternatives that include this mitigation based not on any issue with the mitigation itself, but rather because “leaders of the [PG&E Learning] Academy preferred to finish the restructuring that was already taking place before considering adoption of instructor led training for the Fitness for Duty module of the ‘Leading Forward New to Leadership’ training.”⁷² This, like with the contractor safety risk, reveals a disconnect between the RAMP analysis and the mitigations that are actually implemented. It seems as if the PG&E Learning Academy had a pre-determined plan for how they were going to implement Fitness for Duty Training independently of the RAMP analyses, with no or limited opportunity for either the RAMP analysis to inform the PG&E Learning Academy or for the PG&E Learning Academy to inform the RAMP.

As noted in Section III, bundled mitigation plans should consider the interactions between mitigations that have overlapping exposures and purposes. The tools and technology mitigations proposed in this chapter are a good candidate for this.

R. Cyber Attack

The Cyber Attack risk has a Tail Average MARS of 107.75, ranking it 11th highest among the 22 risks. The proposed mitigations are a continuation of the current mitigations, and so there is no additional proposed spending from 2017 to 2022.

This risk is defined as two distinct sub-risks: attack on information technology with the aim of obtaining unauthorized access to data, and attack on operational technology with the intent of crippling PG&E’s ability to control the flow of gas and/or electricity to customers. These events have very different drivers and consequences, so they should be

⁷² ORA Appendix A at p. 2: ORA DR-01, Question 1.

place in separate sub-risks. It would be helpful if PG&E clarified which of these sub-risks its current controls and proposed mitigations address, particularly when a mitigation addresses drivers associated with only one sub risk.

The combination of the mitigations into broad categories such as “Identify” and “Protect” makes it easier to understand the otherwise overwhelming number of mitigations proposed. However, this bundling of the mitigations makes it difficult to evaluate each of the individual mitigations and how they relate to the sub-risks and their drivers. ORA recommends that PG&E include tables similar to Tables 18-3, 18-6, and 18-7, that break out the plans by the individual mitigations so that it is clear which mitigations address which drivers.

Given the challenges associated with obtaining data on cyberattack events, PG&E does a reasonable job in estimating the frequencies associated with these events. PG&E does not provide any RSEs for its mitigations due to the “complex and innovative” nature of the risk. ORA would like to see an effort to quantify the effects of the considered mitigations in the next RAMP. To this end, PG&E should propose more metrics to measure the effectiveness of specific mitigations. This is particularly important because PG&E suggests that it chooses its current scope, rather than the reduced scope in Alternative Plan 2, in part to allow for the evaluation of emerging tools and technologies.⁷³ Therefore, PG&E should explain how it will evaluate the effectiveness of its proposed mitigations.

S. Insider Threat

The Insider Threat risk has a Tail Average MARS of 233.79, ranking it 6th highest among the 22 risks. The proposed mitigations are a continuation of the current mitigations, and so the proposed total spend of the proposed mitigations is \$0 from 2017 to 2022. This risk is defined as the potential for employees or non-employee workers with current or previously authorized access to PG&E’s assets to use their access and knowledge to negatively affect PG&E or its customers.

⁷³ PG&E RAMP Report at p. 18-25.

As noted in the SED report, this risk actually consists of a variety of different events, which is reflected in the number of risk events identified in the risk bowtie.⁷⁴ ORA agrees with SED's suggestion to either reframe this risk as a cross-cutting risk if the proposed mitigation remains programmatic and broad in nature, or absorb it as a risk driver in the associated stand-alone risks for more targeted mitigations.

The proposed mitigation is described as making additional investments to Internal Threat Intelligence Data and Analytics Strategy, with no additional funding above 2017-2019 levels. Both the current mitigation and proposed mitigation are described so vaguely that it is unclear what the additional investments are, or how the mitigation addresses the risk.

Finally, no RSEs are provided for risks in this chapter, with the justification that "there is no definitive model of human behavior through which one can estimate outcomes with high specificity." While the Insider Threat is an ambiguous and complex threat, SME judgment has been used to produce RSEs for other ambiguous and complex risks in the report, like employee fitness for duty. In addition, there being no definitive model of human behavior is exactly why probabilistic modeling is useful. The nature of the threat in this case should not preclude the ability to estimate the effectiveness of the mitigations.

T. Records and Information Management

The Records and Information Management risk is a cross-cutting risk with a Tail Average MARS of 19.81, ranking it 17th highest among the 22 risks. The total spend proposed is \$73,768,316 from 2017 to 2022. This risk is defined as "not having an effective records and information management program that may result in a failure to construct, operate, and maintain a safe system and lead to property damage and/or loss of life."⁷⁵

As a cross-cutting model, the drivers and frequency of the risk is derived by aggregating the portion of the standalone risks for which records and information management (RIM) is a precursor. While this is appropriate for identifying the frequency

⁷⁴ SED Report at p. 131.

⁷⁵ PG&E RAMP Report at p. 20-1.

of the event, the model should not preclude the identification of drivers that have a causal relationship with the risk. Identification of risk drivers allows those without subject matter expertise to evaluate the usefulness of the proposed mitigations. In both the Climate Resilience and Skilled and Qualified Workforce cross-cutting risks, PG&E identifies both the stand-alone risks that contribute to the cross-cutting risks and the factors identified as risk drivers. For example, “Qualification wasn’t identified” for the Skilled and Qualified Workforce risk, or “sea-level rise” for the climate change resilience risk. A similar approach should be used for the RIM risk.

As noted in Section III, PG&E should provide a more detailed explanation regarding how the standalone risks were chosen and their link to the cross-cutting model. In the RIM risk, in particular, PG&E seems to consider 18 risks in its model,⁷⁶ yet only 12 risks are included as drivers in the RAMP chapter. It is not clear what distinguishes the risks that were included from those that were not.

U. Skilled And Qualified Workforce

The Skilled and Qualified Workforce (SQWF) risk has a Tail Average MARS of 4.96, ranking it the lowest among the 22 risks. The total spend proposed is \$6,110,000 from 2017 to 2022. This risk is defined as, “A worker performing tasks for which he/she does not have the skill or is not qualified and as a result causes an adverse event that leads to a serious injury or fatality.”⁷⁷

This chapter has the strength of quantifying the frequency of the risk, especially compared to the other cross-cutting risks, and the mitigation effectiveness based on data rather than solely SME judgement. In addition, this chapter acknowledges that “if [they] implement all of the mitigations proposed, the cumulative impact will be less than the sum of the individual mitigations.”⁷⁸ In some cases, PG&E attempts to account for these interactions in the RSE, as is the case with the RSEs for the ‘On the Job Support – Mobile Technology for Foremen and Crew Leads’ mitigation and the ‘Enhance TIL and GDL’,

⁷⁶ “20-ERIM-Enterprise Records Management – PG & E 2017 RAMP-B.xlsx”

⁷⁷ PG&E RAMP Report at p. 21-2.

⁷⁸ PG&E RAMP Report at p. 21-18.

which are adjusted to account for interdependence between the two mitigations. While PG&E does not yet have the data to consistently and quantitatively adjust RSEs to account for such interactions, ORA appreciates the effort in this chapter to acknowledge these potential effects and how they might lead to an inflated or deflated RSE.

V. Climate Resilience

The Climate Resilience risk is a cross-cutting risk with a Tail Average MARS of 665.33, ranking it 2nd highest among the 22 risks.⁷⁹ The total spend proposed is \$4,583,000 from 2017 to 2022.⁸⁰ PG&E describes the risk as “impacts attributable to climate change on PG&E’s infrastructure, operations, employees, and customers associated with 11 identified RAMP risks”, and defines the risk event as “failure to effectively adapt to a changing climate”. It is unclear what “effectively adapt” means to PG&E. ORA recommends that PG&E define the specifics of “effectively adapt” such that mitigation plans in future revisions of Climate Resilience in RAMP can be properly evaluated for their effectiveness in preventing the specific risk event from occurring.

Climate Resilience is analyzed with two timeframes, 2022 and 2050, and two greenhouse gas emission scenarios, low and high. The six drivers of climate impacts studied are: major storm events, sea level rise, subsidence, heat waves, wildfires, and drought. PG&E’s results show:

- Sea level rise had the largest multiplier at 34.37 for Scenario B in year 2050.
- Hydro System Safety – Dams has the greatest percentage of risk attributed to impacts from climate change at 44%.
- Majority of 2050 B MARS Attribute Score (Tail Average) is due to financial, reliability, and safety calculated MARS scores.⁸¹
- Motor Vehicle Safety, Employee Safety, and Contractor Safety represent the greatest Expected Value and Tail Average consequences in terms of Safety – Injuries and Safety – Fatalities.

⁷⁹ Scenario 2022 B.

⁸⁰ PG&E RAMP Report at pp. 22-12, 22-14.

⁸¹ PG&E RAMP Report Work Papers. Table 5, WP 22-13.

ORA recognizes PG&E's efforts to quantify the increase in frequency of risk events involved with a changing climate, and recognizes that the strategies proposed are "foundational" and not direct mitigations. Other strengths in this chapter include using sources from scientific papers and other reputable sources for modelling multipliers of each climate driver as detailed in the workpapers. However, there are areas of improvement for PG&E's Climate Resilience chapter.

ORA agrees with SED's report regarding PG&E's lack of an explanation for how exposures of PG&E's footprint to climate change drivers are calculated by PG&E's Risk Owners and SMEs. It is ORA's understanding that PG&E consulted the Risk Owners and SMEs in regards to the percentage that climate change drivers will have an impact on the risk drivers for each different RAMP risk.⁸² However, it is unclear how these percentages were derived and then translated to the percentage each RAMP risk represents for total exposure to climate change as listed in Figure 22-1.⁸³ ORA recommends that PG&E explain and describe how the percentage for each risk is calculated and what the expected impact climate change drivers will have on the risks. It is unclear how climate change drivers will affect the identified 11 stand-alone RAMP risks.

Given that PG&E has categorized the strategies as "foundational" and Climate Resilience as a cross-cutting risk, ORA recommends PG&E explain its next steps in addressing the Climate Resilience risk in future iterations of the RAMP. This includes, but is not limited to:

- How will the calculated MARS score for each RAMP risk be factored into future revisions of RAMP?
- Will PG&E continue to present Climate Resilience as a cross-cutting risk, or will it incorporate Climate Change as a driver in the corresponding standalone risks? ORA recommends that as PG&E moves towards more specific mitigations for climate change resilience, it considers whether addressing the risk in separate chapters would be more beneficial than the overarching, programmatic

⁸² "RAMP-2017-PhI_DR_ORA_001-Q10Atch111.xlsx"

⁸³ PG&E RAMP Report at p. 22-2.

mitigation strategy that the cross-cutting risk model is designed for.

V. CONCLUSION

ORA agrees with SED and other parties that the RAMP is an evolving process that should benefit from continued learning and improvement. ORA recognizes and appreciates the efforts of PG&E to prepare this first-ever RAMP filing. In particular, PG&E has recognized the shortcomings of its analyses and identifying steps to improve them. In summary, ORA has the following suggestions for PG&E's future RAMP reports:

- Remove Trust as a consequence category, and reweight the consequence categories so that the weighting of natural units is consistent;
- Increase the granularity of incident drivers and exposure units to better account for heterogeneous risk profiles;
- Improve model inputs, give greater weight to vetted PG&E-specific data to ensure that model outputs properly reflect PG&E's experience, and utilize methods to account for data uncertainty;
- Improve the quality of the alternative mitigation plans proposed, ensuring that they are potentially desirable and feasible;
- Adjust calculation of RSE to account for potential interactions between mitigations, and mitigations for which benefits extend beyond the rate case period;
- Improve the clarity by providing values such as the total and annual risk reduction of mitigations, clarifying drivers for cross-cutting risks, and being consistent in which timeframe the RSE and the total cost of mitigations plans are presented;
- Move towards being able to optimize spending across risks, including the identification of risk tolerances, the calculation of RSE on an enterprise level, and the consideration of the EV MARS in addition to the TA MARS in prioritizing risks.

ORA's comments, particularly those regarding the quality of model inputs, increased exposure granularity, and optimization across risks, are intended to be long-term objectives for the model as PG&E obtains more robust data and develops its expertise in risk modeling. Some recommendations, including those regarding improved RSE

calculations, greater transparency, alternative proposals, and uncertainty quantification, can be achieved on a shorter timeline and would greatly improve the model or the ability of parties to understand and evaluate the models.

Respectfully submitted,

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